



Waste-to-Energy, Hydrogen Infrastructure, Fuel Cell Project at a U.S. Military Installation

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Project Purpose

- Implement a H₂ Infrastructure at a U.S. military installation that provides both fuel flexibility and onsite storage.
- Enhance energy security by providing an additional source of power in the event of an electrical grid outage.
- Leverage resources from the DoD Energy Conservation Investment Program (ECIP)

Background

- Utilize Anaerobic Digester Gas (ADG) from a waste water treatment plant (WWTP) as input fuel for a fuel cell at a U.S. military Installation
- The Waste-to-Energy, H₂ Infrastructure, Fuel Cell Concept (WTE-H₂-FC) is system described as the following:
 - ADG exits the WWTP and is treated by a scrubber
 - ADG then enters the fuel cell system
 - The reformer creates a H₂-rich stream from the ADG
 - A small portion (<10%) of the H₂ is diverted from the stack to a separate H₂ storage and dispensing system, while the rest of the H₂ enters the fuel cell stack

Concept

- A WTE-H₂-FC Concept design based on the following diagrams

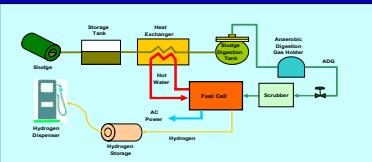


Figure 1.
Waste-to-Energy, H₂ Infrastructure, Fuel Cell Design

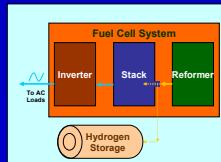
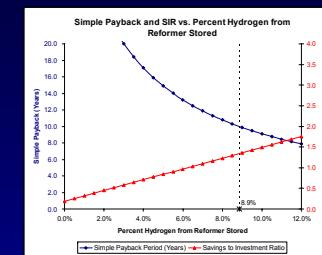


Figure 2.
Fuel Cell / H₂ Storage Concept

Objectives

- Perform a feasibility analysis on the WTE-H₂-FC Concept based on the following:
 - Ft. Stewart, GA Installation Capabilities
 - 10 Mgal/day waste water treatment plant
 - ADG produced can support a 200 kW fuel cell at 78% capacity, 24 hrs/day
 - ECIP Requirements
 - Simple Payback < 10 years
 - Savings-to-Investment Ratio > 1.25

Results



- Concept meets ECIP requirements by storing 8.9% H₂ produced
 - Amounts to a H₂ production of 23 kg/day
- Other goals to satisfy ECIP
 - Minimum electricity cost: \$0.10/ kWh
 - Minimum 90% availability

Economic Analysis

- Assumptions used for the analysis

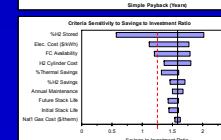
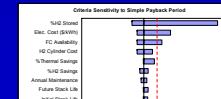
Criteria	Value	Criteria	Value
Initial Stack Life (Years)	4	Waste Water Treatment Plant Cap. (Mgal/day)	6
Subsequent Stack Life (Years)	8	Methane (CH ₄) Content in ADG	69%
Rated Fuel Cell Electrical Capacity (kW)	200	Energy Content of CH ₄ (BTU)	1000
Rated Fuel Cell Thermal Output (BTU/hr)	900,000	Annual Maintenance Cost (2008 \$US)	\$40,000
Fuel Cell Operating Capacity	100%	Capacity of H ₂ Cylinder (SCF)	200
Fuel Cell Electrical Efficiency	37%	H ₂ Savings Realized	90%
Fuel Cell Availability	90%	Cost per H ₂ Cylinder	\$12.50
Heat Exchanger Efficiency	67%	Cost of Electricity (per kWh)	\$0.10

Conclusions

- A WTE-H₂-FC project at Fort Stewart could meet ECIP requirements, but considerations include:
 - Economic benefits rely heavily on the market value of H₂
 - Calculated savings are dependent on the cost differential between onsite production of H₂ vs. commercially purchased H₂
 - Currently no end-use application for H₂
 - Supplemental fuel line, in addition to the ADG supply, is recommended for reliable fuel cell operation

Sensitivity Analysis

- Percentage of H₂ stored is most critical factor
- Others factors that could hinder project goals:
 - Local Electricity Cost
 - Fuel Cell Availability



Future Work

- Create design-build drawings
- Implement design / Field installation
- Identify end-use application of H₂
- Publish ERDC Tech Report, *Waste-to-Energy Hydrogen Infrastructure Project, Volume II*
- Evaluate additional H₂ fueling station concepts for military installations